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D₃ of γ *Cassiopeiae* appears on my plates as a very faint bright line. To be seen visually, as it has been in the past, it would have to be considerably stronger. In about a dozen stars several enhanced metallic lines show bright. ϕ *Persei* is the best example found. The lines of this star correspond closely to the strongest lines of the solar chromosphere, with the exception of the lines of magnesium, sodium, and helium. The lines of sodium and helium are dark in ϕ *Persei*, and magnesium is not represented at all. Many of the bright lines are double. That the lines of the atmosphere of a solar star should be present in the spectra of Class B stars argues for the unity of the stellar system.

In order to trace evolutionary relationships we should have an extensive series of observations of stars beginning with the Wolf-Rayet type and extending through the late subdivisions of Class O up to Class B; and, again, observations of numerous objects of Classes A and F, since there are stars classified from B0 to F0 which have bright lines.

THE CLUSTER VARIABLE RR Lyr ϵ .

By C. C. KIESS,
Fellow in the Lick Observatory, 1910-1913.

In a previous article, appearing in this journal for August, 1912, the writer has attempted to give an account of the general features and characteristics of the cluster variables, and also some theories which have been put forth in explanation of this peculiar type of variation. Of the isolated cluster variables, the brightest one so far as known is RR Lyr ϵ , which at maximum is of magnitude 7.0 and at minimum of magnitude 7.8. This star has been observed both photometrically and spectrographically at the Lick Observatory during the summer and autumn months of 1912. Credit is due to Dr. S. D. TOWNLEY for making a number of the earlier photometric observations. All the other observations of the star, photometric and spectroscopic, were made by the writer.

The light curve derived from the Lick observations differs but slightly from that based on the observations made by WEN-

DELL at Harvard and confirms the conclusion that RR *Lyræ* belongs to the cluster variables. At minimum the light is practically constant for approximately one third of the period. The rise from minimum to maximum is extremely rapid. A comparison of the times of maximum as observed at the Lick Observatory with the first epoch of maximum observed by WENDELL, resulted in a new period of 0.566826 day. In a letter to Director CAMPBELL, HERTZSPRUNG of Potsdam stated that he had observed a *photographic* maximum of RR *Lyræ* on J. D. 2418919.448 Gr. M. T. A comparison of this date with the dates of visual maximum resulting from both the Harvard and Lick observations revealed the remarkable circumstance that in the case of RR *Lyræ* the maximum intensity of the photographic rays occurs 2.7 hours before the maximum intensity of the visual rays. A new epoch of visual maximum is J. D. 2419697.764.

The spectrographic observations were made with the one-prism instrument attached to the 36-inch refractor. Measurement of the spectrograms showed a variable velocity in the line of sight, the period of velocity variation being coincident with the light period. The variable is therefore a spectroscopic binary. Its orbital elements were derived by the method of LEHMANN-FILHÉS and later corrected on the basis of a least-square solution.

RR *Lyræ* possesses the characteristic that is so pre-eminently a distinguishing feature of the *Cepheid-Geminid* variables—namely, that maximum light occurs at the time of maximum velocity of approach toward the observer. Hence, there can be little doubt but that the light variations of the bright star are due, directly or indirectly, to the influence of the less brilliant member of the system. That eclipses are in no way responsible for the observed light variations is evidenced by the relations existing between the light and velocity curves. We may conclude, therefore, that in so far as the observed features of RR *Lyræ* are characteristic of the group, the cluster variables are but extreme types of the family of variables of which the *Cepheids* and *Geminids* are members.

The most plausible theory advanced in explanation of short-period variation is the variation-in-absorption theory due to

DUNCAN. Although this theory offers an explanation of the synchronism between light maximum and velocity minimum, yet in the case of RR *Lyræ* it fails to account for the discrepancy that exists between the times of visual and photographic maxima. Consequently, we conclude that before a satisfactory theory can be formulated additional knowledge is required as to the nature of the light variations of the short-period variables as observed in light of different wave-lengths.

April, 1913.

THE VISUAL REGION OF SPECTRUM OF BRIGHTER
CLASS A STARS.

By E. PHOEBE WATERMAN,
Vassar College Fellow in the Lick Observatory, 1912-1913.

Plates of 132 Class A stars were secured with the one-prism spectrographs in regular use with the 36-inch refractor, covering, in two sections, the region K to H β . The plates used were Seed 23, stained for the visual region with WALLACE's three-dye solution. The lines present in the visual region of each spectrum were identified by comparison with the spectrum of α *Cygni*, in the Hartmann spectrocomparator, and the wave-length of each line obtained by measuring and reducing (by the Hartmann formula) several spectrograms of this star. Lines which were not found in its spectrum and which appeared in spectra of sub-class A5, were identified from neighboring α *Cygni* lines and the wave-lengths obtained by measurements of A5 spectra with sharp lines.

The results secured were briefly:—

(1) The lines in the visual region agree in general appearance, in source, and in intensity, with those of the photographic region. The contrast with the continuous spectrum is slight, however, and the lines much more difficult to obtain than in the photographic region, so that the criteria afforded by the visual region seem too few to make this part of the spectrum essential in classification work. The *b* group of magnesium shows steady development from sub-class to sub-class, and is of value for classification purposes; the D lines are exceedingly